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METHOD OF OBTAINING COMPACTION PRODUCTS FROM REFRACTORY METALLIDES USING ULTRASONIC ACTIVATION

V. R. Pokryshev and V. I. Marchenko

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METHOD OF OBTAINING COMPACTION PRODUCTS FROM REFRACTORY METALLIDES USING ULTRASONIC ACTIVATION

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ABSTRACT

The authors describe a device and a method developed by them in order to investigate the influence of ultrasonic vibrations on the processes of sintering, high-temperature pressing, and for the production of compaction products from the powders of metals and their compounds. A laboratory vacuum device is discussed and illustrated.

It is known that during the production of some refractory metallides and intermetallide compounds by the powder metallurgy methods there are difficulties which are eliminated by means of the activation of the process of sintering, including activation by sonic and ultrasonic vibrations [1-3]. /98*

In order to investigate the influence of the ultrasonic vibrations on the processes of sintering, high-temperature pressing, and for the production of compaction products from metal powders and their compounds using ultrasonic activation, we have designed a laboratory vacuum device and developed a method.

An overall view of the device is shown in Figure 1, the block diagram in Figure 2. The device consists of the following main units: vacuum chamber 1 cooled by running water, electric resistance furnace 5 with heat screens, magnetostriction device 2 with an acoustic transformer 3 and a passive vibrator 12, and a lever press 16. The required discharge in the chamber is achieved by a vacuum system consisting of a VN-461 rotation pump and a TsVL-100 diffusion pump. The feed of the magnetostriction device is from a UZG-3 ultrasonic oscillator with a 3-kw capacity.

The ultrasonic vibrations are introduced into the vacuum chamber by means of a half-wave passive vibrator 12. The latter, through a threaded adapter is joined to a half-wave concentrator which, in turn, is joined to the magnetostriction device and fixed to the stand 19, where the water circulates. Through a sleeve located in the upper lid of the vacuum chamber, in its center, into the /99
chamber is introduced the die 14, to which is supplied static pressure from the lever press 16. In the upper end of the die there is a recess in which is placed a titanium-barium ultrasonic vibration receiver 15.

The resistance furnace, with a capacity of producing temperatures of

*Numbers given in the margin indicate pagination in original foreign text.

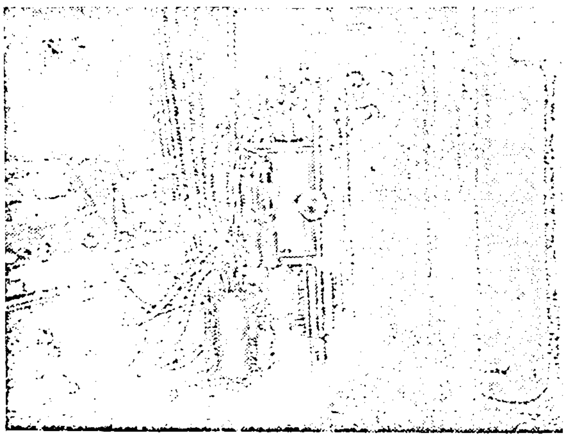

Figure 1
Overall view of device

2000-2500°C, is made of MPG graphite (compacted) and is fed by an alternating current from a 15-kw reducing transformer. The furnace is mounted on copper semidisks, installed on massive water-cooled current leads.

The measuring unit of the device makes it possible to measure the electrical resistance, the temperature, the absorption, and the velocity of the propagation of ultrasound in the specimens. This makes it possible to affect dynamic control of the process of shrinking and the sintering of the specimens.

In contrast to the existing methods of sintering powders of metals and refractory compounds, the authors propose a method for a sintering using the simultaneous action of static pressure and dynamic loads generated by the ultrasonic field.

1) vacuum chamber; 2) magnetostriction device; 3) acoustic transformer; 4) ultrasonic oscillator; 5) resistance furnace; 6) reducing transformer; 7) autotransformer; 8) potentiometer; 9) pulse oscillator; 10) low frequency amplifier; 11) oscillograph; 12) passive vibrator; 13) die yoke; 14) die; 15) ultrasonic oscillation receiver; 16) lever press; 17) indicator; 18) specimen; 19) cooling jacket.

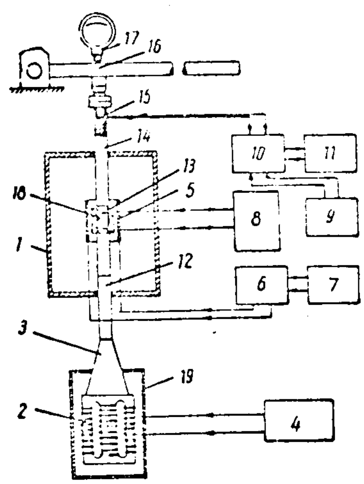

Figure 2

The die with the sintered powder is placed in the yoke made of refractory materials which covers the passive vibrator secured to the magnetostriction device. From above, into the yoke is introduced the die 14, through which static pressure generated by the lever press is transmitted. Through the passive vibrator 12, the ultrasonic vibrations are transmitted to the specimen 18. The amplitude of the end of the vibrator may be changed by means of an electrical fine tuning of the oscillator and smooth tuning of the frequency on the same concentrator. The oscillation amplitude of the end plane of the rod is determined by a horizontal microscope with the cap removed. Amplitude vs frequency curves are plotted. These curves are used as guidelines in the selection of modes of exposure of the powders to the ultrasound.

The shrinking of the powder during sintering is measured by the indicator device 17 to an accuracy of 0.001 mm. The temperature of the specimen is measured by a pyrometer and a platinum-platinum-rhodium thermocouple. The power of the heater is varied by regulating the voltage in the primary coil of the reducing transformer by means of an autotransformer.

Control of the kinetics of the sintering process is achieved by means of a special ultrasonic receiver (titatinum-barium emitter), amplifier, and an oscillograph by the ultrasonic absorption in the sintered specimen in the course of the process. Furthermore, from the pulse oscillator 9 to the titanium-barium emitter it is possible to supply an electrical pulse which is converted by the emitter into ultrasound. The time of passage of the pulse through the sintered specimen and the dimensions of the specimen may be used to determine the velocity of the ultrasonic wave. In addition to the ultrasonic control, provisions are also made in the course of sintering to measure the electrical conductivity of the specimens.

The device proposed may be used to sinter powders of metals and refrac- /100 tory compounds using the effect of ultrasound on the sintered specimen, as well as without this effect. It is also possible to change the amplitudes of ultrasonic oscillations and to control the kinetics of the processes of sintering and high-temperature pressing. By changing the sintering temperatures and the magnitudes of the static and dynamic loads, it is possible to obtain optimum sintering modes. The possibility of control over the course of the process makes the solution of this problem easier.

REFERENCES

1. Fedorchenko, I. M. and R. A. Andriyevskiy: Fundamentals of Powder Metallurgy (Osnovy poroshkovoy metallurgii). Izd-vo AN UkrSSR, Kiev, pp. 288-300, 1963.
2. Rakovskiy, V. S.: Powder Metallurgy (Poroshkovaya metallurgiya). No. 4, NIITavtoprom, Moscow, pp. 43-48, 1956.
3. Garber, R. I., L. M. Polyakov, and I. G. Malik: FMM, vol. 10, No. 4, pp. 590-596, 1960.

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